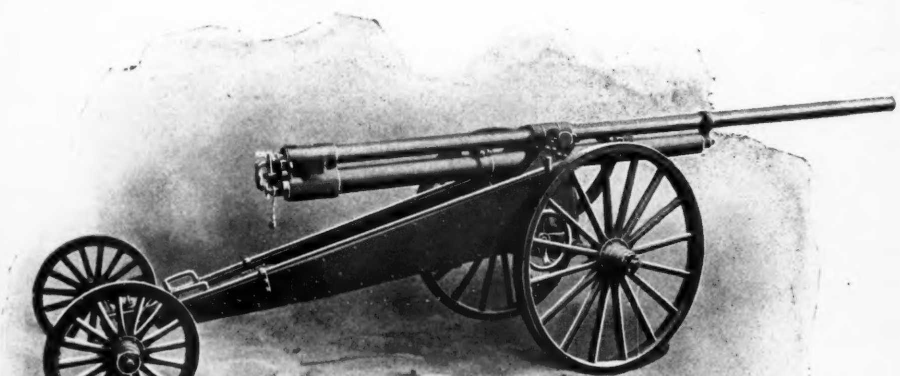
Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. III. NEW YORK, NOVEMBER, 1898. No. 9



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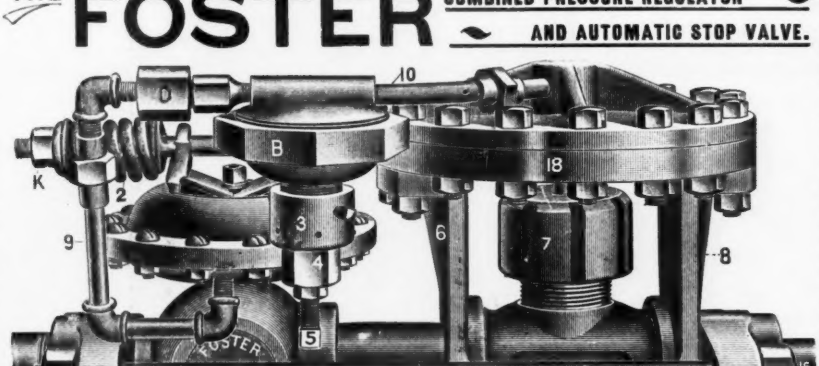

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Compressed Air.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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In a recent conversation with Mr. Geo. E. Ames, Supervising Engineer of the Anaconda Copper Mines in Montana, the question of freezing in compressed air pipes was brought up. Mr. Ames is a practical man, having recently taken charge of the Anaconda mines after an experience of 18 years with the Union Iron Works, San Francisco. Large volumes of air are used in the Anaconda mines, compressors being installed at different points, with an aggregate capacity of 50,000 cubic feet of free air per minute, delivered at 80 pounds pressure per square inch. Among the installations is one where the compressed air after leaving the generating station is conveyed over ground a distance of several thousand feet and then carried down a shaft into the mine.

During the winter months it was found that at times it was difficult to get air pressure in the mine, and Mr. Ames set about to discover the cause. Being an engineer he looked at the case from a theoretical as well as a practical standpoint, and discovered that the air pipe was in fact a surface condenser, the cold Montana winds keeping it at a low temperature, and the hot compressed air on the inside coming in contact with the cold surface of the pipe was reduced in volume and temperature, and as it went along it deposited its moisture on the interior surfaces. Air at all times contains moisture. It is called comparatively dry when the humidity is 50 per cent., which means 50 per cent. of the quantity of water required to saturate a given quantity of air. At times it is as high as 90 per cent., and even more. This water is in the air, though we cannot see it, and it is just as certain to be condensed to a visible and a troublesome liquid when the temperature is lowered, as steam may be converted into water. It is altogether a question of temperature. Steam is in a condition of vapor only because it is held up by heat. The air we breathe passes over water surfaces and absorbs moisture, just as the water is taken from wet clothes while hanging on the line, and the warmer this air is the more moisture does it take up.

This water is carried around with the air and up into higher regions, where it meets with cold currents and is condensed into clouds. These clouds represent nothing else but the visible moisture which is present in the air drawn into a compressor, and it is certain to form a cloud and rain, either in the air receiver, the pipe line or the rock drill or pump that uses the air. This is a process of nature, and knowing the cause, as Mr. Ames did, it was not difficult to find a remedy. This he found by putting in a series of old boilers outdoors near the engine room. The air at 80 pounds pressure and hot was passed from one of these boilers to the other until its temperature had been lowered to the initial point, and when it started up the hill it was practically of the same temperature as the pipe line, and it had left its moisture, or a large portion of it, behind. Old boilers when strong enough are especially well suited for use as compressed air condensers, because of the large metallic surface exposure through the shell and the flues. The compressed air passes around the tubes and the free winds of winter blow through them. It is best to so place these boilers that they will get plenty of wind. It is better to put them in a horizontal than in a vertical position, and if wind is not available, use a blower, or better still, a cold stream of water. If practicable submerge the receivers. Suitable means should, of course, be provided for trapping the water. Pet cocks or globe valves are sometimes used, but water traps working automatically will serve the purpose better. It is not necessary, however, as some suppose, to take the water out as fast as it is formed, for as long as the temperature of the water is

lower than that of the air there can be no absorption of water by the air. This simple remedy, which Mr. Ames has applied at the Anaconda mines, might save time and money at other places, and it is mentioned here hoping that it may have this result.

Refrigeration by Compressed Air.

Description of a System which has been in Extensive Use for Years in the United States Navy.

By Leicester Allen.

IN the "American Machinist" for Dec. 30, 1897, Mr. Richard E. Chandler describes his failure to cool water by blowing through it previously compressed and cooled air. Some editorial remarks upon this failure in the same issue express a desire that others will be encouraged to recount their experience in this line, and having had a large and varied experience in the use of compressed air for cooling refrigerating compartments, in buildings and on shipboard, in cooling potable water and also in cooling strong brine for use in ice-freezing tanks, I feel that I ought to accept the challenge.

Contrary to the experience of Mr. Chandler, my experience has been a successful one; a process and apparatus for dynamic refrigeration, employing compressed air and effecting all the results above named, invented and put into use by me, has been in extensive use for years in the United States Navy, has been adopted for the Japanese war vessels, and is also in operation on many merchant and passenger steamers and steam yachts.

I would very much like to make the mode of cooling by compressed air comprehensible to the ordinary steam engineer. Though this is by no means an easy task, with permission of the editor I will attempt it.

All dynamic or mechanical refrigeration by use of compressed air or other gases depends upon the following fundamental principles, which have been both mathematically and experimentally demonstrated:

(a) The performance of work by the molecules of any substance or material, as by air or steam in expanding, is done at the expense of heat in such substance or material; heat is thus converted into work.

(b) The performance of work upon the molecules of any substance or material, as in compressing air or steam, results in an increase of heat in the material; work is thus converted into heat.

(c) If air, or other gas, be first compressed, and the heat produced by the work of compression be then taken out of it (cooling by water is the usual way of doing this), and if it then be expanded, *expending the work of expansion upon some other exterior body or substance,* it gets very cold, and in this state may be used to extract heat from, or cool, other substances or bodies.

The italicized words express a condition absolutely essential to a succesful refrigerating process.

It was reasoned in the editorial remarks upon Mr. Chandler's failure (above referred to) that as air cannot expand without performing work, and that as the performance of work always implies a simultaneous or prior conversion into mechanical energy (actual or potential) of the heat equivalent of the work, and as the conversion of the heat equivalent into actual mechanical energy in the performance of work by expanding air is coincident with the expansion, compressed air, following full stroke in an air engine (thus doing no work, but acting the same as a liquid or solid to simply transmit pressure), ought, when expanding from the exhaust, to produce the same *final* cooling effect as when expanded in any other way.

Now it is true, as stated in this argument, that *air cannot expand at all without doing work;* that the expansion of a definite weight of air from a given pressure and temperature to a given lower pressure and temperature without any accession of heat while expanding always results in the performance of a definite quantity of work, and that this work is the equivalent of a definite amount of heat previously contained in the air which expands, and which cannot simultaneously exist as both heat and work; but it does not, therefore, logically follow that *when the last part of a cycle of operations* in compressing and expanding air has been reached, there will have resulted a reduction of temperature (below the initial temperature of the air passed through the

cycle) representing anything more than a small fraction of the heat equivalent of the work performed by the expansion.

Whether the *final* reduction of temperature below the initial temperature will be the equivalent of the work of expansion (less what may be lost through frictional reheating), or not, *will depend upon the application of that work.*

If, subsequently to the expansion, all the work generated by it be reconverted into heat, before the close of the cycle of operations, and this heat be expended in reheating the expanded air, there will be no final lowering of temperature; there will generally be some final increase of heat due to friction.

Therefore in the argument (issue of Dec. 30) under consideration, though the premises are all sound, the conclusion is not justified thereby. The compressed air after following the piston full stroke is capable of yielding the full cooling equivalent* of the work of expansion, *if expanded under proper conditions;* letting it exhaust freely into the outer air, or into water, as Mr. Chandler did, is not the right way.

Pushing the compressed air after it has followed full stroke (and before expanding) into the cylinder of another engine of such size and cut-off that at the end of its stroke the expansion would be complete—the piston applying the work of expansion to some exterior object—would be, though indirect, a right way to get the full available cooling effect. But how is it that expansion into a surrounding medium fails to do the same thing?

To gain clear ideas we must regard the whole cycle of operations—not merely some part of it—and determine whether the cooling effect of one operation is, or is not, counteracted by another.

Cycle of Three Operations.—Compression not followed by cooling before free expansion from a valve opening adds the full heat equivalent of the work of compression to the finally expanded air; the latter will then be hotter and will have a larger volume immediately after expansion than before it was compressed, and the third operation of the cycle is its giving off of this heat, resulting in its contraction and the resumption of its normal volume. This cycle is, therefore, a heating cycle in its final stage, notwithstanding there is a full expansion of the compressed air. The cooling due to expansion in one operation is not only neutralized in another part, but the entire heat equivalent of the work of compression is ultimately transmitted to the medium into which the air is finally discharged.

Cycle of Four Operations.—This may be the same as the above, except that the air is cooled in some way (say, by water) after compression, and then allowed to expand freely out into a surrounding medium. The heat equivalent of the work of compression is carried away in the cooling water. Now if the expansion be made freely into a gaseous or liquid medium the air expanded will at first be cooled by the full equivalent of the work of expansion, but only a small fraction of this cooling effect will remain available at the end of the expansion.

This can be made plainer by an example of such treatment of a specific quantity of air; the surest way to get right on any question of thermodynamics is to deal with specific quantities.

Let us deal with one pound of air, supposed to be already compressed to 220.5 pounds per square inch (15 times atmospheric pressure at sea level) and cooled to 72 degrees Fahr. (or 531 degrees absolute temperature); thus two of the operations of the cycle have already been performed.

Let us suppose this air confined in a metallic cylinder of 12.555 inches internal diameter and the same internal length. Such a cylinder will just contain the one pound of air, which, at the stated temperature and pressure, will have a volume of 1540.68 cubic inches.

Let us suppose that one end of this cylinder is so arranged that it can be fully and suddenly opened or closed, thus permitting the freest conceivable expansion and instantaneous closure.

Let this cylinder, charged as assumed, be placed in an otherwise vacuous inclosure hermetically closed and having a net cubic capacity of 11.415 feet over and

*Cooling is the passage of heat out from a body or *negative* heating as distinguished from *positive* heating or the passage of heat into a body. The equivalent of either is numerically expressed in thermal units, the number expressing passage of heat out having the minus sign, while that expressing passage of heat in has the plus sign. In this mathematical sense it is therefore as logical to write "cooling equivalent" for loss of heat by performance of work as "heat equivalent" for gain of heat in a body upon which work is performed

above the space occupied by the charged cylinder, and let it be also supposed that the walls of this inclosure have the temperature of 72 degrees Fahr., and that they are so well insulated that no heat can penetrate through them.

Now suppose the removable end of the inclosed and charged cylinder to be suddenly opened, and instantly closed again the moment that the air has expanded to atmospheric pressure in the previously vacuous space. Three of the operations of the cycle have now been performed; the previously vacuous space outside surrounding the charged cylinder will be filled with air at 72 degrees Fahr. and at atmospheric pressure; the inclosed cylinder will be filled with very cold air at atmospheric pressure, which is available for refrigerating effect in the fourth operation of the cycle wherein the restoration of the air to the same pressure and temperature as before the compression is completed. The amount of this cooling effect is easily calculable, on the supposition that it can all be practically applied. The theoretical temperature of the air remaining in the cylinder is 217.08 degrees Fahr.; this is a very low temperature, but, as the air in the cylinder is only 0.163 pound, the total amount of refrigeration is small as compared with what is possible under proper conditions. The total theoretical cooling effect possible from one pound of air expanded from 220.5 pounds per square inch and 72 degrees Fahr. down to atmospheric pressure, if applied to cooling water from 80 degrees Fahr. down to 40 degrees Fahr. is 61.2 negative British thermal units, of which there are obtained in our supposed experiment not quite 10 B. T. U.

The total work of expansion is 52,992 foot pounds, which is *all* expended in generating velocity in the one pound of air at the time of its release from pressure. It would be easy to calculate the average velocity thus generated, but it is sufficient to note that what air remains in the cylinder has substantially no velocity. The 0.877 pound of air shot out strikes the walls of the inclosure and the impact and arrest of motion regenerates the heat which previously generated the work, and thus all the *final* cooling effect is confined to the air remaining in the discharged cylinder.

The interval of time between the discharge and the impact which reheats the air is so short that, practically, these events may be regarded as simultaneous, and the air forced out of the cylinder might be considered practically as performing work and expending it upon itself simultaneously, so that the cooling effect of the expansion is neutralized by the heating effect of the work performed upon itself; but, as a matter of fact, the events are successive; heat is converted into work, work is converted into the potential of velocity and, lastly, the potential of velocity is converted into heat again at the instant of impact.

If, instead of into small vacuous space, the compressed air were allowed to escape into a limitless vacuous space, it would never lose its velocity and never regain its temperature, and consequently the cycle of operations would never be completed.*

If, instead of into the vacuous space, the air were permitted to expand freely into a gaseous or liquid medium, the reheating effect of the arrest of its motion by impact would be just the same, and all the residual cooling effect would be that of the air remaining in the cylinder.

The heating of gaseous molecules by impact against surfaces of solids or liquids, or against other gaseous molecules, is precisely analogous to the heating of projectiles when shot against targets or when they meet in their trajectories.

The supposititious experiment described explains why in an air engine following full stroke the air remaining in the cylinder until it is pushed out gets very cold. While the air is expanding out of the exhaust what so escapes reheats by impact and a little by friction in passing through the nozzle; while that which, after more or less complete expansion, is thrust out by the returning piston is very cold, because it has expended its work of expansion in shooting out the air in advance of it, and, when at last thrust out, it has practically no velocity, and cannot therefore be reheated by impact. There is, therefore, in the operation of such an engine, the local, restricted cooling effect which causes annoyance by freezing up ports, precisely as stated in the editorial remarks upon Mr. Chandler's failure.

*** A complete cycle of operations restores the air to the same volume and temperature it had previous to compression.**

Let us now suppose the cylinder containing the compressed air to be replaced by a cylinder of the same internal diameter. With a piston having a stroke of 85.7 inches, the cylinder being so insulated that no heat can pass into or through its walls from or to the contained air (expansion or compression of gases under such conditions is said to be *adiabatic*.

Our one pound of air, compressed and cooled as before, will now occupy 12.555 inches of the length of the cylinder behind the piston. Therefore, when the air has followed the piston through this distance, let there be a sharp cut-off and thereafter let the air expand, driving the piston, whose rod (extending out to some means for performing work, say, a crosshead, pitman and crank) applies all the work of expansion to the performance of outer work, such as pumping water, assisting to drive an air compressor or lifting a weight. At the end of the stroke the whole space in the cylinder except that occupied by the piston will be filled with air at a pressure of 14.7 pounds per square inch, and at the theoretical temperature of 217.08 degrees Fahr. Now when the exhaust opens this air will not rush out, of itself; there will be no further expansion, and the air will remain in the cylinder till pushed out; when so pushed out it has a comparatively low velocity, and therefore is heated very little by friction and scarcely at all by impact; we therefore reach the final stage of the cycle of operations with the whole pound of air very cold and theoretically requiring 61.2 thermal units to restore it to its condition before compression, and thus to complete the cycle. All this heat will now be abstracted by the cold air from warmer surroundings or contiguous substances, whether water, air, substances to be preserved by refrigeration, or brine for use in an ice-freezing tank.

In practice, of course, such a proportion of stroke to diameter in an air-expanding cylinder would never be met with; it was only assumed for the purpose of argument. Practically, also, theoretical results are not very nearly attained, as perfect adiabatic compression or expansion is impracticable, and there are frictional and other losses.

The more gently the air can be pushed out of the cylinder the less reheating it will receive. Suddenness of exhaust is detrimental.

The whole matter can be summed up as follows:

(a) Air in expanding always performs work.

(b) As we cannot expand into a limitless vacuum, as much of this work as is converted into velocity will be reconverted into heat by impact.

(c) Because, if the air be expanded out of a valve opening, without following and expanding behind a piston, all the work of its expansion is converted first into velocity and immediately thereafter by impact converted into heat, the cooling effect of the expansion is immediately neutralized by this heat, and this method of cooling produces only a small local refrigerating effect plus that resulting from the slight molecular cohesion.

—*American Machinist.*

MINE HAULAGE.

MR. E. P. Lord, Superintendent of H. K. Porter & Co., Pittsburg, Pa., in a paper read before a recent meeting of the Coal Operators' Association, reviewing the progress of compressed air, and particularly of mechanical haulage by compressed air, and says:

" Mining has been one of the most active means of giving prominence to compressed air. In these days of active competition and imperative demand for decreased cost of production, greater economies and improved appliances for cheapening the mining of coal have been absolutely essential to profitable mining. New fields, as soon as developed, have felt at once the necessity of installing the most approved machinery for mining, pumping and haulage; in fact, these improvements have been imperative to keep in business. The mule, which has so long been used for hauling, has been very generally supplanted by more powerful agents, steam, electricity and compressed air. It is to the latter power as applied to the motor for haulage purposes that I intend to principally confine my remarks.

" In much work—in mine tunnels, confined spaces, etc., compressed air has fully demonstrated its superiority over steam or any other power. The work accomplished with it in your own Jeddo Tunnel,

at Hazelton, needs no reference to here. Early uses of compressed air hardly presaged the wonderful development and application of this power to-day. For mine haulage it is very largely supplanting the steam locomotive, with its attendant disadvantages, and now electricity is about its only competitor. Until this competition manifested itself, air was generally considered a very undesirable power at best, and in many installations, more particularly haulage, it was not thought of. I do not wish to be construed as saying that electricity and compressed air do not very frequently work in mutual harmony. Each has its own field of work, for which it is singularly fitted, and where no question of competition can arise.

"Electricity can be used in most cases quite successfully for haulage. It can also be used for pumping, and made a success as far as operation is concerned, but in many cases at a large excess of cost over compressed air. But when you come to cut coal with electricity, many operators claim that no such results can be obtained as with compressed air, to say nothing about the increased cost of installation and subsequent operation. I have found it extremely difficult to get any statements from those using electricity for coal cutting, and there is no doubt or question but that there are some veins of coal which cannot be cut with the type of machine which is driven with electricity that could be successfully cut with what is called the punching or pick machine. Where compressed air is superior for transmitting power for coal cutting and pumping, is it not reasonable to conclude that a good deal of consideration should be given to it for haulage ?

"Most of our engineers frankly admit that the electric motor is not an economical machine where the use of power is to be variable and intermittent, it being essentially a constant speed machine. If we so block an electric motor that it cannot move, a considerable current of electricity will run through, without doing any work; while a compressed air engine wastes no air or energy in starting, for air only escapes with piston movement.

"The average mine engineer will usually show the liveliest interest when approached on the subject of an air haulage plant; but when he is called upon to choose between air and its very universal and most elaborately advertised competitor, electricity, no doubt he feels that the best known and understood agent is the best and safest in his case, although the compresed air plant, if successfully installed and started, might prove the most economical to his company.

"I am pleased to state that in the introduction of our motor we have found in the anthracite district the most exacting, but at the same time, most tolerant listeners to our claims for recognition; and the reports which have, and are now, reaching us from plants already installed among the operators of your region lead us to hope for, and promise even greater achievements in the advancement of this simple but all-powerful agent, compressed air.

"The last few years have witnessed a very remarkable development of compressors and compressed air apparatus, due no doubt quite largely to the active competition of electricity in the many fields where this power is used. The great improvement made in compressors, together with reduced cost, have led to their more extensive adoption and the enlargement of their uses. In all respects its progress has fully kept pace with that of electricity. The compressor people are now called upon to design and construct machines to develop heat and produce cold; to move air with a force only sufficient to press gold into a sensitive tooth, and to blow the shot from a cannon. There is hardly a department of any large shop or manufactory that cannot testify to the remarkable economies that this power, ingeniously applied to various machines, has established. There are not less than 200 distinct and established uses of compressed air—to 90 per cent. of which electricity is inapplicable; and in the remaining 10 per cent., constituting the field open more or less to the other agencies besides air and electricity, we find air generally has the advantage. Except within the last few years, compressed air catalogues have been almost the only literature on this very important subject, while to-day we can hardly pick up an engineering paper without running across some article, paper or special mention of the great benefits that this new power is establishing for its recognition in the mechanical world.

"Comparison with Other Power Agencies.—Compressed air has marked advan-

tages over any other class of haulage, in that it is free to go wherever there is a track laid; the distance run with one charge of air is only limited by the capacity of the motor tanks. Great advancement has been made in the improvements of compressors, pipe lines, pipe connections, motors, methods of charging, etc.; so that for efficiency it is admitted that compressed air runs electricity very close for a long-distance transmission. It is equally efficient and safe in fiery and non-fiery mines, and materially assists ventilation by the air given out by the exhaust. Too much stress must not be laid on this, for efficient ventilation must be provided for in any case; but compressed air is now used for driving mining machines in rooms or in butt entries, ahead of the general work and beyond the range of general ventilation. It not only supplies the necessary power, but furnishes an ample amount of fresh air, thereby materially reducing the risk to life and property. In the butt entries and rooms where ventilation has been difficult, and where, on account of low roofs, light rail, etc., other classes of power have not been introduced, the compressed air locomotive has been installed with very manifest success."

A Gasoline Air Compressor for Bridge Work.

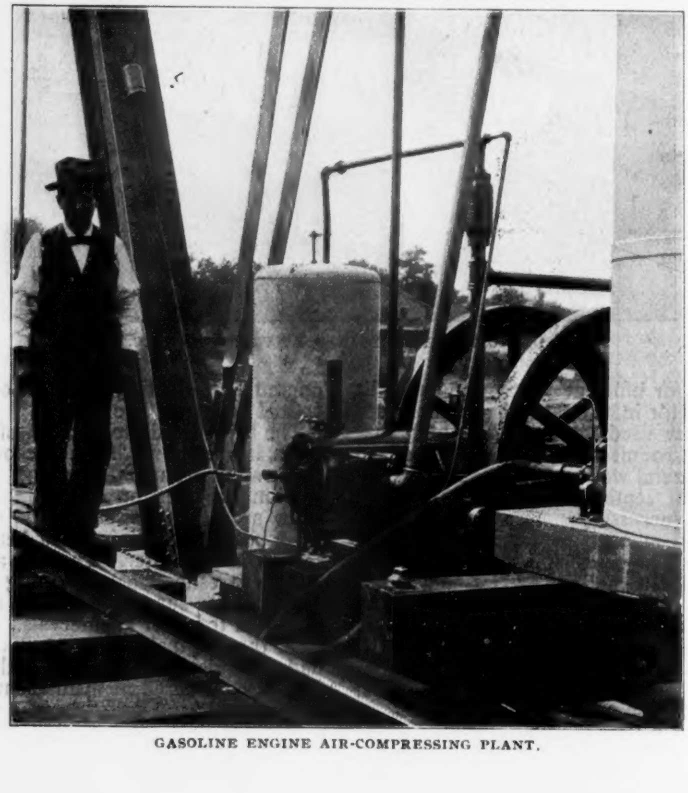
THE Illinois Central Railroad is at the present time engaged in an interesting piece of work in connection with the strengthening of its bridge at West Point, Ky. The chief interest attaches to the manner in which the conditions of shop work are made practicable upon a bridge already erected and under traffic by the use of a portable plant for generating compressed air for the operation of riveting tools. The power is supplied by a 12-horse power gasoline engine furnished by Fairbanks, Morse & Co., and the tools operated are riveting hammers of the Chicago Pneumatic Tool Co.

ILLINOIS CENTRAL BRIDGE, AT WEST POINT, KY.

The bridge and the location of the plant upon it are shown by the accompanying engravings from photographs. The operations in question are confined to the draw span, 265 feet in length, supported on a stone center pier at a height of 65 feet from the water. The end abutments of the trestle work forming the approaches are supported by two steel caissons tied together at intervals.

In the original construction the bridge had a wooden floor resting on the chords. It was considered of insufficient strength for the traffic and it was decided to put on

USING COMPRESSED AIR IN BRIDGE RIVETING.

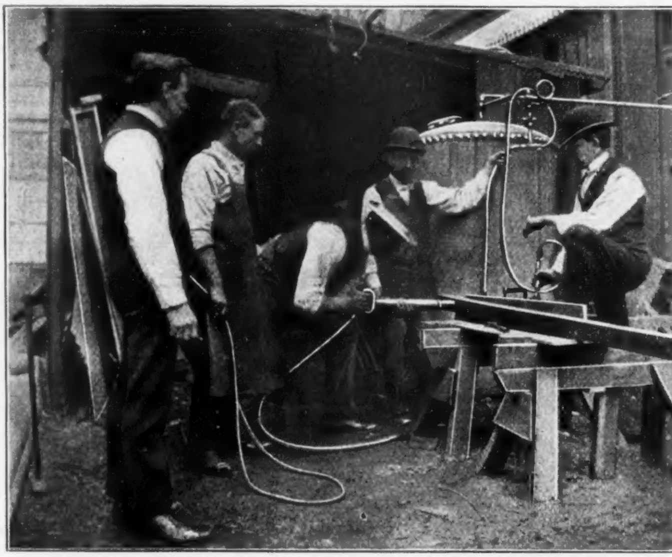


GASOLINE ENGINE AIR-COMPRESSING PLANT.

a new floor structure. This was accomplished by hanging cross girders from the pins of the bridge, upon which should rest two sets of stringers, the latter being built up and riveted. The stringers are 28 inches deep and placed about 18 inches apart. The inner set of stringers carries the ties and supports the track. Double sets of braces were riveted to the crossbeams for connecting the stringers, and also for attaching the lateral braces, and for this riveting, requiring ⅞-inch rivets and passing through two and three thicknesses of plates, some experimenting was necessary.

It was found difficult to use the yoke riveter which would ordinarily have been put upon this kind of work, owing to the peculiar conditions of the structure. The space between the stringers was insufficient to admit the frame, and it became necessary to use the pneumatic hand hammer. Two kinds of hammers were furnished by the Chicago Pneumatic Tool Co., the numbers "0" and "000" Boyer, and good work has been accomplished. It was also impossible to use the pneumatic rivet holder-on, and the hand "dolly" was substituted.

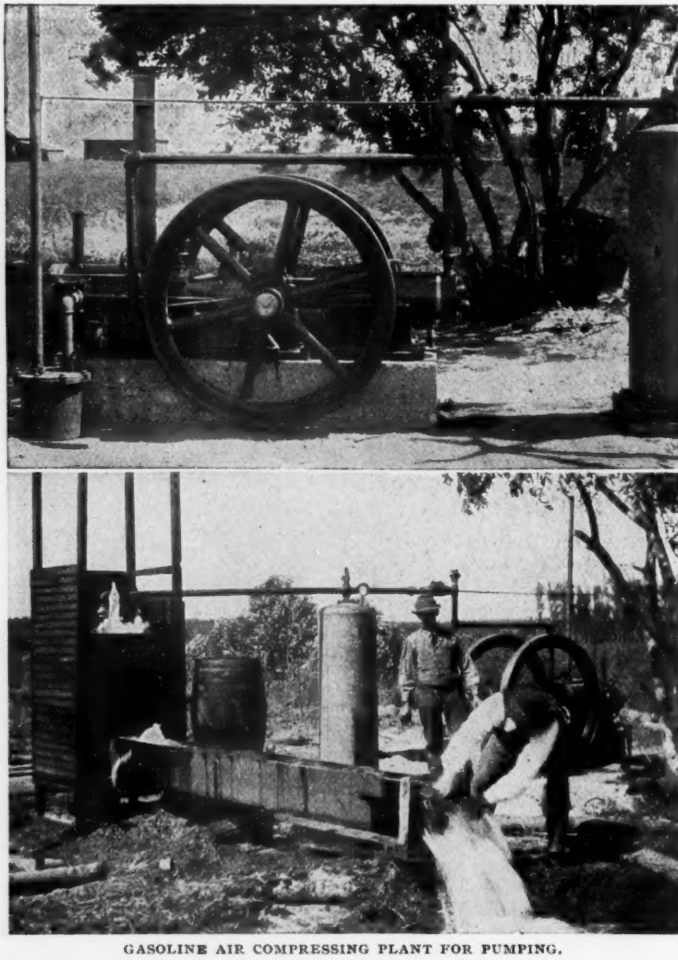
The compressor plant is the direct-connected gasoline engine air compressor, which has been especially designed by Fairbanks, Morse & Co. for isolated and portable plants. It is located on one side of the track, being placed on two 6 x 12-inch timbers bolted together and lagged fast to timbers placed across the stringers underneath the rails. The compressing plant is located at the middle of the span and air carried by means of a pipe. Openings are provided in the pipe at short intervals, and hose connections made for operating the riveting hammers at any required position. The engine itself transmits power directly from the engine piston to the air piston. The air cylinder is single acting, having one set of valves, and a mechanically operated unloading valve relieves the compressor when the desired pressure has been reached. The engine is thus left under no load until the pressure has descended to a determined point, and under this condition the governor admits sufficient gasoline only to maintain speed. This feature has an important bearing on economy, since the fuel used is in direct proportion to the amount of work actually performed, and the automatic features reduce to a minimum the cost of attend-



THE BOYER HAMMER DRIVING 1-INCH RIVETS

ance. In the present case the engine operates continuously all day without attention. The lubrication is by sight feed cups.

One of the engravings herewith shows the location of the compressor and also of the rivet-heating forges. These are run at present by hand blast, but it has been suggested and planned to run a small jet of air to the forges for this purpose. The whole operation of setting a rivet consumes practically 15 seconds on an average. On account of the inaccessibility of some of the rivet holes the time consumed is considerably more than 15 seconds. It is estimated, however, that one of the riveting machines is doing the work of three hand operators and the 12-horse power gasoline engine compressor is of suitable capacity to supply three or four riveters.



GASOLINE AIR COMPRESSING PLANT FOR PUMPING.

The smaller of the two sizes of riveting hammers used was designed for ¾-inch rivets, but it was found that it did effective

work on those of 7/8-inch diameter. It was, however, a little slower in the work on these rivets, and the large size hammers with pistol grip were fitted with an additional handle for holding in position. The work has thus been expedited by using two large hammers on the 7/8-inch rivets, and working the smaller hammers on the 3/4-inch rivets on the upper structure of the bridge, which is being changed from lattice bracing to plate for giving additional strength.

The foreman and the entire gang engaged upon the work were accustomed to hand riveting only, and it was somewhat difficult to convince them that the work could be done by air. Later the foreman expressed himself highly in favor of the pneumatic machines. It is stated also that

THE BOYER HAMMER ON BRIDGE RIVETING.

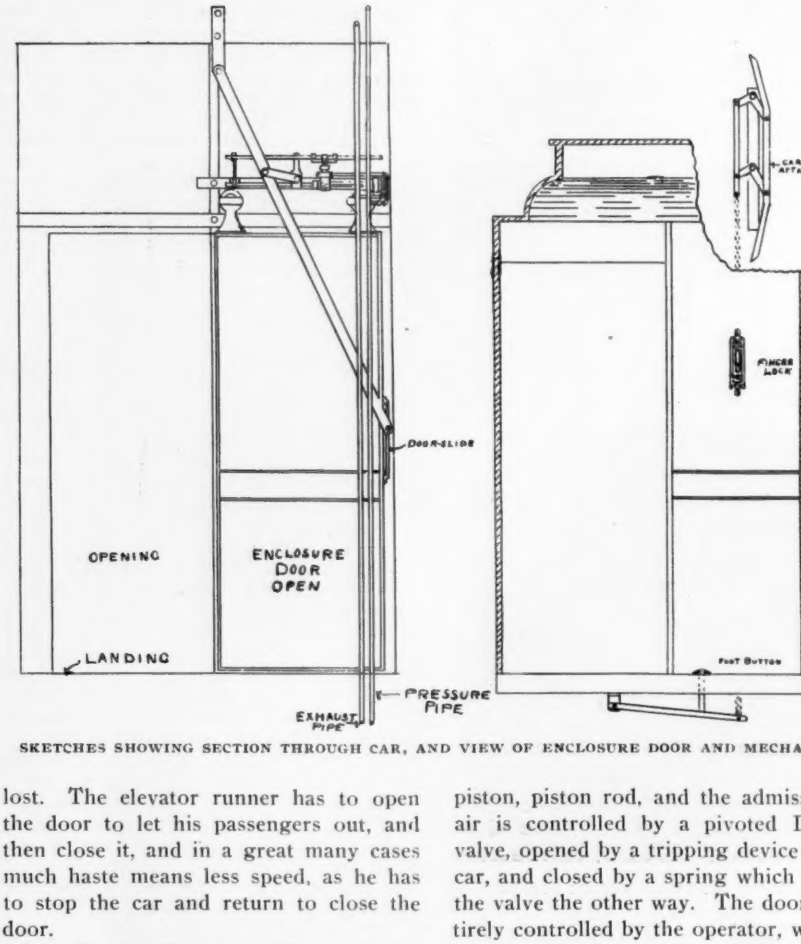
the pneumatic tool is superior, especially for reaching down between the deep stringers, as in the case of hand riveting it would be necessary to use a riveting bar about 3½ feet in length, and it is almost impossible to keep the bar from jumping from the rivet at every stroke of the hammer. In this way time is lost and poor work the result.

The large hammer referred to as furnished by the Chicago Pneumatic Tool Co. is an entirely new device, recently designed by them for heavy work. It is constructed on the same principle as the lighter forms of the Boyer hammer, but has a capacity up to 1 inch, and has been used upon 1½-inch rivets. A hook bar is used for holding up rivets, and its speed is such that rivets can be driven faster than they can be made ready and put in place. Six to seven seconds are said to be ordinarily sufficient for driving a rivet. It has been designed especially for heading down staybolts, placing truck rivets, pipe riveting, etc. The Risdon Iron Works of San Francisco report in regard to the work of this tool on pipe riveting that they have driven 200 1½-inch rivets per hour at a cost of one-fifth that of doing the same work by hand. The tool is illustrated in one of the accompanying engravings, driving 1¼-inch rivets. While known as the large hammer, the term has relation to capacity rather than weight, the latter being 10½ pounds.

The gasoline air-compressing plant in use upon this bridge is in extensive use in mining work for operating rock drills, and in irrigating. The illustrations shown on page 530 are of a plant installed by Fairbanks, Morse & Co. at Gardena, Cal., where a 12-horse power gasoline engine air compressor discharges 700 gallons of water per minute from a 7-inch bored well, with a total head of 29 feet. The air pressure is 45 pounds and the cost of running the plant ten hours is given as $1.35, using distillate at ten cents per gallon. The principal advantage, aside from that of economy in operation, claimed for the plant, is the fact that the machinery is entirely above ground and accessible. The adaptability of the same plant for the operation of pneumatic tools on bridge work may be considered as an important advance, affording in the field the facilities which have hitherto been available only in the shop.—*Railway Age.*

Pneumatic Elevator Door Mechanism.

IN these days of sky scraper office buildings the elevator is looked upon as the soul of the building, and it is the elevator service that rents the offices more than any other detail. A good deal of thought and studying is done to increase the efficiency of the elevator service. You may run high-speed elevators, but you cannot make your passengers run on and off the elevator, and that is where the time is

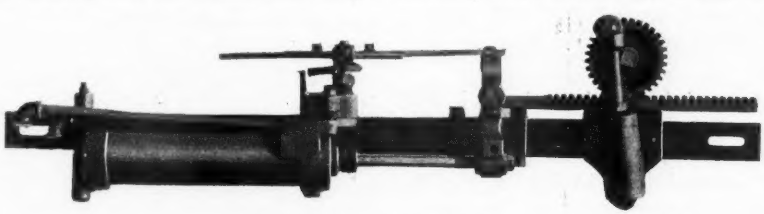


SKETCHES SHOWING SECTION THROUGH CAR, AND VIEW OF ENCLOSURE DOOR AND MECHANISM.

lost. The elevator runner has to open the door to let his passengers out, and then close it, and in a great many cases much haste means less speed, as he has to stop the car and return to close the door.

The Burdett-Rowntree Manufacturing Co., of 76-82 W. Jackson Street, Chicago, and of 120 Liberty Street, New York City, are the inventors and patentees of pneumatic elevator door mechanism, which causes the door to open by the time the car is level with the floor, and when the car is ready to leave the floor the man releases the foot button and goes on, knowing that if the door opened it will have to close. The mechanism is simplicity itself, consisting of a cylinder, piston, piston rod, and the admission of air is controlled by a pivoted D slide valve, opened by a tripping device on the car, and closed by a spring which throws the valve the other way. The door is entirely controlled by the operator, within a range of 20 inches, 10 on each side of floor. There is a small bar which interlocks with the valve trip and locks the door, preventing it from being opened from the outside; also, in the '98 machines, the full pressure of air is on the rear end of piston at all times except when opening, and there being no dead centers the door has to keep closed. The doors are practically noiseless, being cushioned on a dash pot of oil, both opening and closing. This does away with all adjustment

of the valves, there being only one small admission cock, which regulates the amount of air needed. The air is supplied from a pipe which runs the full length of the elevator well, tapping it for the machines at each floor. In the basement is placed an automatic air pump, receiver, and a reducing valve, which reduces the air to 15 pounds, that being the pressure used by the machines. The gain in service is very material. In the Surety Building in New York City they claim a saving of 20 seconds per round trip of elevator, and in the course of a day this would add into time very materially. In the Stephen Girard Building, Philadelphia, a 13-story story building, are four elevators, which carry 4,000 people per day. Mr. Dinsmore, Engineer for the Girard Estate, told the writer that they could not begin to handle their traffic without the door mechanism. The largest installation, consisting of 216 doors, is in the Empire Building, New York City. There are 180 single, 26 double, and ten folding gates within the cars. These machines are of the latest designs and with all the changes found necessary since the first plant was installed three years ago. There are now 41 office buildings equipped with these gates, and there are a large number of orders for projected buildings. They have been found to be of the greatest utility in department stores, where their traffic consists of women and children, who are naturally slow and timid in entering and leaving the elevator, and where it is necessary for the operator to have his eye on the passengers and his hand ready to assist them, his foot operating the door. In B. Altman & Co.'s dry goods store they have double doors opening to the full width of the car operated by the mechanism. Also Marshall Field of Chicago, and R. H. White's department store of Boston, are now equipping their elevator doors with these devices.



ELEVATOR DOOR MECHANISM.

Pneumatic Gun in Warfare.

INTEREST in dynamite guns has been stimulated by the practical tests given to them in action during the late war with Spain, in Cuba. The Sims-Dudley field gun, being at the front, proved to be very efficient, and demonstrated that in the hands of intelligent artillerymen this gun is successful. In the fight of the "Rough Riders" before Santiago Sergeant H. A. Borrowe had charge of the gun. He reported that the gun had been in action three times, and in all 20 shots had been fired with great effect. Other regiments were supplied with these guns and did excellent service. The testimony of officers and correspondents is to the effect that these guns have a fine moral effect, as well as being very destructive. The gun shown on the cover may be taken to represent the most advanced construction. It is popularly called a "dynamite gun," although any desired form of explosive may be used. It usually throws a projectile charged

with Nobel's gelatine, which can be handled, stored and used with greater safety than any other nitroglycerine explosive, and still produces in its explosion a more destructive effect than that of any other explosive. It is impossible to throw such material by the direct fire of powder, as the concussion would without doubt explode the charge. Therefore, the power used in the ejection of the projectile is compressed air, generated by a small charge of smokeless powder. The volume of gas produced by combustion of the powder compresses the air contained in the tubes of the gun, and this air acts as a yielding cushion between the powder and the projectile, and as the transmitter of the force from the one to the other. The ejecting force thus acts upon the projectile with a prolonged and gradually increasing effect, instead of with the sharpness and suddenness of direct powder explosion.

The bore of the gun here shown is 2½ inches and the length of the projectile tube is about 14 feet. This tube is of a special composition, having a tensile strength of 80,000 pounds to the square inch. The barrel is not rifled, the rotation of the projectile being accomplished after leaving the gun by the action of the air upon the inclined wings on the spindle. The total length of the projectile is 36 inches and it weighs when loaded 11½ pounds. It carries four pounds of Nobel's gelatine, which is equal in destructive power to at least 80 pounds of ordinary powder, and a Merriam fuse provides for the explosion upon impact or decided retardation, as by water, or the explosion may be arranged to occur at a predetermined interval subsequently.

Below the projectile tube is the combustion and compression chamber, which is a 4½-inch steel tube 7 feet long. The firing is by an ordinary cartridge shell, containing seven or eight ounces of smokeless powder. This cartridge is placed in a small central tube, which projects only a short distance forward into the combustion chamber. The breech mechanisms are both thrown open by a single motion, the projectile and the cartridge are inserted at once, the breech mechanisms are closed by a single movement, and the gun is ready to fire. The firing is done by pulling a lanyard in the usual manner. Absolute certainty of operation is assured by the details and arrangement of the mechanism. There is no possibility of any discharge of the gun until both the projectile and the cartridge are in their correct positions and everything is ready to fire. In these particulars, Mr. Sims, the inventor of the well-known dirigible torpedo, has contributed much to perfect the original invention of Mr. Dudley.

When the cartridge is fired the charge is driven forward in the large tube, while all the contained air is driven backward and through a large connecting passage into the projectile tube, so that practically all the air contained in both tubes is between the projectile and the hot gases. The action of the explosion upon this large body of air also insures a gradual instead of a sudden application of the pressure upon the projectile. The pressure is, however, applied so effectively that the range of this gun is from one and one-half to two miles, with a still greater range for those of larger caliber.

The gun, as shown, weighs 1,044 pounds. It can be quickly taken apart for transportation on mule back, or in difficult places all the parts can be carried by men. The parts can be assembled and the gun made ready for action in ten minutes. The cost of each discharge of this gun is but $35, while the guns using powder alone, with which it would be fair to compare it, weigh many

tons and cost hundreds of dollars for each discharge. The zone of destruction caused by the explosion of the projectile is nearly 100 feet, and where its fire is directed at masses of troops the shock is so frightful that many besides the killed and the actually wounded are thrown out of the fight.

The gun may be fired at almost any desired elevation or depression, so as to be available for attacking an elevated position or in firing at an object directly below the gun. The recoil of the gun is inconsiderable, and little noise is produced, so that it is difficult to locate the gun at distances exceeding half a mile. In case of danger of capture the gun is made inoperative by unscrewing the cap from one of the tubes and carrying it off, or by taking off the breech mechanism, which can be done in two minutes.

The larger guns of this type may be used in countermining. Mounted forward on a ship they could clear a channel of all dangerous obstructions, exploding by concussion submarine mines as the ship advanced. This interesting gun is made by the Sims-Dudley Defense Co., 120 Liberty Street, New York.

Air Hoist in Mining Operations.

The Mansfield Copper Mining Co. in Germany have installed a compressed air hoist in their mines, as it enables them to raise or transfer the cars from one track to another more expeditiously than heretofore possible by use of the hoisting screw. A compressed air cylinder is arranged upon a movable frame suspended at a height of 6 feet 8 inches. The frame can be moved on the rails with great ease, the air being supplied bv an india rubber hose. The piston rod of the air cylinder is connected to a system of levers, which are arranged for the purpose, grabbing and lifting the wagon as soon as the air valve is opened. The releasing and lowering of the wagon is effected by opening the exhaust valve.

Air Supply Company.

A company has been formed in British Columbia for the purpose of supplying air in "quantities to suit" to the mines in and around Rossland. It is known as the Rossland Air Supply Co., Limited. Their plan is to develop the power at Beavers Creek, about ten miles from Rossland, by means of the Taylor system, fully illustrated and described in the September number of "Compressed Air." Two Compressors would be installed on the Creek, and their product of compressed air would feed into a common pipe line transmitting at comparatively high pressure through wrought iron pipe 14 inches in diameter to where it will be used, the amount of power proposed to be delivered being sufficient to take care of at least 200 3¼-inch drills, or their equivalent in air horse-power.

NOTES.

The Foster combination regulator and stop valve, for high initial air pressure is already in highly successful operation in several coal companies' mines in Pennsylvania, and an order has recently been filled for these valves to be applied to locomotives now in construction for Japan.

The general catalogue issued by the Whiting Foundry Equipment Co., Harvey, Ill., contains illustrations and descriptions of a variety of compressed air cranes, air hoists, elevators, and many other appliances suitable for foundries. It will be interesting for all who are in need of up-to-date foundry equipment. Compressed air having found its way to foundries, its usefulness there is much appreciated.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of "Compressed Air." We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz., all communications should be written on one side of the paper only; they should be short and to the point.

Editor "Compressed Air":

Can you inform me where I can get a compressed air motor for direct connection, which can be used to operate the apparatus in a printing establishment? The concern of which I am manager employs 12 large cylinder presses and various other machines, such as paper cutters, job presses, embossing press, binding machinery and trimming machines, and my idea is to operate the whole plant by compressed air.

The situation is this: We are now running our plant by electricity, and a friend tells me that he is operating a number of portable tools by compressed air and that he has just put in a large air compressor, which affords him a large surplus of air, and he would supply me with a part of his power. His factory is about two blocks away from my establishment.

Can the plan be worked, and if so, what means should I take to put it in operation, and where can I buy the apparatus or contract to have the work done?

Yours truly,

PRINTER.

Brooklyn, N. Y., Oct. 10, 1898.

Our friend proposes a very interesting installation of compressed air. His plan is entirely feasible, but we shall attempt to point out some of the obstacles that he will meet in his efforts to accomplish what he desires, and some of the advantages to be derived by the change.

In the first place, the materials used in a printing office are of a highly combustible nature, and electricity, while not absolutely dangerous, has erratic notions as to conduct, and a certain fear of something happening is constantly in the minds of those who have to handle it. To relieve a printing office from the danger of fire is next to impossible, but you can lessen the liability and probably reduce the cost of fire insurnace.

In hot weather such as we experienced during the past Summer, many printing offices suffered severely from the humid atmosphere, accompanied by heat. Fine printing cannot be done under such conditions, and several large printing offices in this city had to close up during the severest spell because their work could not be satisfactorily done. Rollers would melt and printed paper would not dry. The use of compressed air in a printing office would naturally keep the atmosphere of the office in a better condition and always have a tendency toward keeping it cooler. Of course, there is no danger of fire.

So the proposition to change from electricity to compressed air is a fair one, and only needs proper handling by competent persons to make the installation a success.

You should first assure yourself beyond the possibility of a doubt of the supply of air which has been so kindly offered to you. Your friend may be tempted to put in more compressed air tools and have use for this surplus air.

We cannot tell you where to go to buy the apparatus or with whom you may contract to have the work done. Several concerns have been established for the purpose of equipping all kinds of plants with compressed air apparatus, but we do not know how far they have advanced, or whether they are prepared to furnish suitable appliances for this work.

In fact, for a successful installation the whole proposition hinges on the motor. If an efficient motor for direct connection could be obtained the matter of installing

this plant is reduced to a simple contract for ordinary pipe work. Much study and thought have been devoted to the subiect of an efficient and economical compressed air motor, but up to date we do not know of any one that has attained these qualities except in a very limited degree. Of all motors constructed none seem to have reached a point where they could be declared successful. There are many in the market, but they are only used in places where convenience and not economy is required. The demand for a successful motor is already great and is growing every day, and the experiments made in this direction have apparently been along lines that are faulty. It needs some new genius to solve this problem.

A few points are suggested looking toward what is required in a successful motor; one that would come near the economy of the steam engine, occupy little space, and be reliable and easy to maintain; one that will increase or decrease the required volume of air used in proportion to the work done. In other words, if the work is regular, the cut-off and pressure can be adapted so that the motor will be fairly economical. Should the work increase, the initial pressure must also be increased and the cut off take place earlier in the stroke. Should the work decrease, the initial pressure must also be decreased, and the cut-off take place later in the stroke. On these lines a motor can be made to use air in proportion to the work done.

Even with the motor secured the proposition of our printer friend involves a public supply of compressed air to insure permanency and economy. Much has been said about a public compressed air supply, but nothing of a practical nature has been done in this country. An ordinance has been passed in the city of Richmond, Va., granting to Joseph H. Hoadley of New York, and others, the right to use the water power adjacent to the city for the purpose of supplying compressed air for power for refrigerating, ventilating and cooling. This would be a public supply and would be distributed throughout the city for the various purposes now assigned to steam and electricity. This is the only place that we know of where this step has been taken. Nothing has been done toward installing the plant, but from the names of those who appear to be connected with the enterprise, we may expect that it will at some time be fulfilled. Perhaps some of our readers have a motor that has not yet been developed; if so, they will find a wide market already open for it, and the promise of profit is great.—Ed.

PATENTS GRANTED SEPTEMBER, 1898.

Specially prepared for COMPRESSED AIR from the Patent Office files by Grafton L. McGill, Washington, D. C.

610,528.—Pneumatic Despatch Tube. Samuel R. Gayton, Philadelphia, Pa.

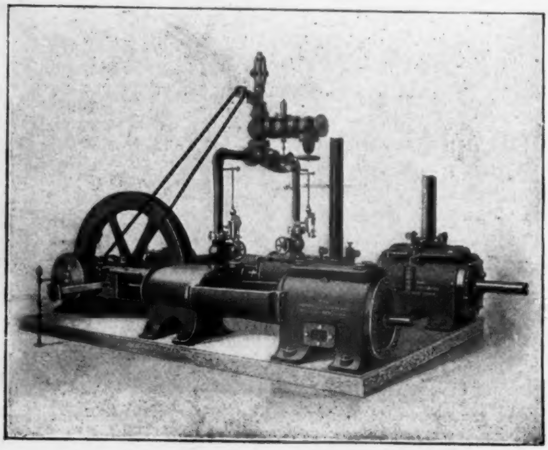
A catch or finger projects into the tube through an opening in its side. The catch is formed with sloping sides and a shoulder, whereby a carrier pointed or sloping at one end and approximately flat at the other can be inserted into the tube point first only. The catch is mounted upon a spring-actuated, pivoted lever which permits it to move out of the way of the advancing carrier.

610,608.—Air-Compressor Inlet-Valve. J. G. Leyner, Denver, Colo.

The stationary stem, threaded axially in the hood to the nut portion of the latter, is provided with an enlarged head-portion at one end, the valve having a hollow shank mounted to slide reciprocatively on the head and body-portion of the stem. The valve has a chamber in its hollow body-portion with a coil-spring therein around the stem arranged to bear at one end against one end of the chamber and at its opposite end against the head-portion of the stem to hold the valve in operative engagement with the valve-seat of the hood.

610,790.—Tide-Water Air Compressor. Denie Beckers, San Pedro, Cal.

The compressing float comprises a casing having compartment chambers open at their outer ends. The reservoir is provided with valve-controlled, communicating apertures between itself and the compartments. A valve secured to the float allows the escape of any water that may enter the reservoir. The cylinder is mounted on the reservoir and is also provided with valve-controlled apertures communcating between the interior thereof and the reservoir. The plunger working in the cylinder is connected with the motor-wheel.



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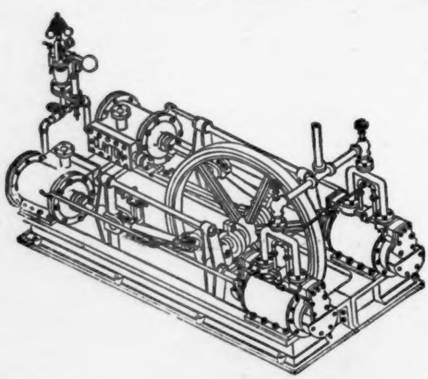

and every other purpose to which Compressed Air can be applied.

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